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*LIII. Electrical Experiments, with an Attempt to account for their several Phænomena; together with some Observations on Thunder-Clouds, by John Canton, M.A. and F.R.S.*

*Experiment 1.*

Read Dec. 6, 1753. **F**ROM the cieling, or any convenient part of a room, let two cork-balls, each about the bigness of a small pea, be suspended by linen threads of eight or nine inches in length, so as to be in contact with each other. Bring the excited glafs tube under the balls, and they will be separated by it, when held at the distance of three or four feet; let it be brought nearer, and they will stand farther apart; intirely withdraw it, and they will immediately come together. This experiment may be made with very small brass balls hung by silver wire; and will succeed as well with sealing-wax made electrical, as with glafs.

*Experiment 2.*

If two cork-balls be suspended by dry silk threads, the excited tube must be brought within eighteen inches before they will repel each other; which they will continue to do, for some time, after the tube is taken away.

As the balls in the first experiment are not insulated, they cannot properly be said to be electrified: but when they hang within the atmosphere of the excited

excited tube, they may attract and condense the electrical fluid round about them, and be separated by the repulsion of its particles. It is conjectur'd also, that the balls at this time contain less than their common share of the electrical fluid, on account of the repelling power of that which surrounds them ; tho' some, perhaps, is continually entering and passing thro' the threads. And if that be the case, the reason is plain, why the balls hung by silk, in the second experiment, must be in a much more dense part of the atmosphere of the tube, before they will repel each other. At the approach of an excited stick of wax to the balls, in the first experiment, the electrical fire is supposed to come through the threads into the balls, and be condensed there, in its passage towards the wax : for, according to Mr. *Franklin*, excited glass emits the electrical fluid, but excited wax receives it.

### *Experiment 3.*

Let a tin tube, of four or five feet in length, and about two inches in diameter, be insulated by silk ; and from one end of it let the cork-balls be suspended by linen threads. Electrify it, by bringing the excited glass tube near the other end, so as that the balls may stand an inch and an half, or two inches apart : then, at the approach of the excited tube, they will by degrees lose their repelling power, and come into contact ; and as the tube is brought still nearer, they will separate again to as great a distance as before : in the return of the tube they will approach each other till they touch, and then repel as at first. If the tin-tube be electrified by wax, or the wire of a charg'd

charg'd phial, the balls will be affected in the same manner at the approach of excited wax, or the wire of the phial.

#### *Experiment 4.*

Electrify the cork-balls as in the last experiment by glass; and at the approach of an excited stick of wax their repulsion will be increased. The effect will be the same, if the excited glass be brought towards them, when they have been electrified by wax.

The bringing the excited glass to the end, or edge of the tin-tube, in the third experiment, is suppos'd to electrify it positively, or to add to the electrical fire it before contained; and therefore some will be running off through the balls, and they will repel each other. But at the approach of excited glass, which likewise *emits* the electrical fluid, the discharge of it from the balls will be diminish'd; or part will be driven back, by a force acting in a contrary direction; and they will come nearer together. If the tube be held at such a distance from the balls, that the excess of the density of the fluid round about them, above the common quantity in air, be equal to the excess of the density of that within them, above the common quantity contain'd in cork; their repulsion will be quite destroy'd. But if the tube be brought nearer; the fluid without, being more dense than that within the balls, it will be attracted by them, and they will recede from each other again.

When the apparatus has lost part of its natural share of this fluid, by the approach of excited wax to one end of it, or is electrified negatively; the electrical fire

fire is attracted and imbib'd by the balls to supply the deficiency ; and that more plentifully at the approach of excited glass, or a body positively electrified, than before ; whence the distance between the balls will be increased, as the fluid surrounding them is augmented. And in general, whether by the approach or recess of any body ; if the difference between the density of the internal and external fluid be increased, or diminished ; the repulsion of the balls will be increased, or diminished, accordingly.

### *Experiment 5.*

When the insulated tin tube is not electrified, bring the excited glass tube towards the middle of it, so as to be nearly at right angles with it, and the balls at the end will repel each other ; and the more so, as the excited tube is brought nearer. When it has been held a few seconds, at the distance of about six inches, withdraw it, and the balls will approach each other till they touch ; and then separating again, as the tube is moved farther off, will continue to repel when it is taken quite away. And this repulsion between the balls will be increased by the approach of excited glass, but diminished by excited wax ; just as if the apparatus had been electrified by wax, after the manner described in the third experiment.

### *Experiment 6.*

Insulate two tin tubes, distinguished by *A* and *B*, so as to be in a line with each other, and about half an inch apart ; and at the remote end of each, let a pair of cork balls be suspended. Towards the middle

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of *A*, bring the excited glass tube ; and holding it a short time, at the distance of a few inches, each pair of balls will be observed to separate : withdraw the tube, and the balls of *A* will come together, and then repel each other again ; but those of *B* will hardly be affected. By the approach of the excited glass tube, held under the balls of *A*, their repulsion will be increased : but if the tube be brought, in the same manner, towards the balls of *B*, their repulsion will be diminished.

In the fifth experiment, the common stock of electrical matter in the tin tube, is supposed to be attenuated about the middle, and to be condensed at the ends, by the repelling power of the atmosphere of the excited glass tube, when held near it. And perhaps the tin tube may lose some of its natural quantity of the electrical fluid, before it receives any from the glass ; as that fluid will more readily run off from the ends or edges of it, than enter at the middle : and accordingly, when the glass tube is withdrawn, and the fluid is again equally diffused through the apparatus, it is found to be electrified negatively : For excited glass brought under the balls will increase their repulsion.

In the sixth experiment, part of the fluid driven out of one tin tube enters the other ; which is found to be electrified positively, by the decreasing of the repulsion of its balls, at the approach of excited glass.

#### *Experiment 7.*

Let the tin tube, with a pair of balls at one end, be placed three feet at least from any part of the room, and the air render'd very dry by means of a fire :

fire : electrify the apparatus to a considerable degree ; then touch the tin tube with a finger, or any other conductor, and the balls will, notwithstanding, continue to repel each other ; tho' not at so great a distance as before.

The air surrounding the apparatus to the distance of two or three feet, is supposed to contain more or less of the electrical fire, than its common share, as the tin tube is electrified positively, or negatively ; and when very dry, may not part with its overplus, or have its deficiency supplied so suddenly, as the tin ; but may continue to be electrified, after that has been touch'd, for a considerable time.

### *Experiment 8.*

Having made the Torricellian vacuum about five feet long, after the manner described in the *Philosophical Transactions*, Vol. xlvi. p. 370. if the excited tube be brought within a small distance of it, a light will be seen thro' more than half its length : which soon vanishes, if the tube be not brought nearer ; but will appear again, as that is moved farther off. This may be repeated several times, without exciting the tube afresh.

This experiment may be consider'd as a kind of ocular demonstration of the truth of Mr. Franklin's hypothesis ; that when the electrical fluid is condensed on one side of thin glass, it will be repelled from the other, if it meets with no resistance. According to which, at the approach of the excited tube, the fire is supposed to be repelled from the inside of the glass surrounding the vacuum, and to

be carried off thro' the columns of mercury ; but, as the tube is withdrawn, the fire is supposed to return.

*Experiment 9.*

Let an excited stick of wax, of two feet and an half in length, and about an inch in diameter, be held near its middle. Excite the glass tube, and draw it over one half of it ; then, turning it a little about its axis, let the tube be excited again, and drawn over the same half ; and let this operation be repeated several times : then will that half destroy the repelling power of balls electrified by glass, and the other half will increase it.

By this experiment it appears, that wax also may be electrified positively and negatively. And it is probable, that all bodies whatsoever may have the quantity they contain of the electrical fluid, increased, or diminished. The clouds, I have observed, by a great number of experiments, to be some in a positive, and others in a negative state of electricity. For the cork balls, electrified by them, will sometimes close at the approach of excited glass ; and at other times be separated to a greater distance. And this change I have known to happen five or six times in less than half an hour ; the balls coming together each time, and remaining in contact a few seconds, before they repel each other again. It may likewise easily be discover'd, by a charged phial, whether the electrical fire be drawn out of the apparatus by a negative cloud, or forced into it by a positive one : and by whichsoever it be electrified, should that cloud either part with its overplus, or have its deficiency supplied suddenly, the apparatus will lose its electricity : which

is frequently observed to be the case, immediately after a flash of lightning. Yet when the air is very dry, the apparatus will continue to be electrified for ten minutes, or a quarter of an hour, after the clouds have passed the zenith; and sometimes till they appear more than half-way towards the horizon. Rain, especially when the drops are large, generally brings down the electrical fire: and hail, in summer, I believe never fails. When the apparatus was last electrified, it was by the fall of thawing snow; which happened so lately, as on the 12<sup>th</sup> of November; that being the twenty-sixth day, and sixty-first time, it has been electrified, since it was first set up; which was about the middle of May. And as Fahrenheit's thermometer was but seven degrees above freezing, it is supposed the winter will not entirely put a stop to observations of this sort. At London, no more than two thunder-storms have happened during the whole summer: and the apparatus was sometimes so strongly electrified in one of them, that the bells, which have been frequently rung by the clouds, so loud as to be heard in every room of the house (the doors being open), were silenced by the almost constant stream of dense electrical fire, between each bell and the brass ball, which would not suffer it to strike.

I shall conclude this paper, already too long, with the following queries:

1. May not air, suddenly rarefied, give electrical fire to, and air suddenly condensed, receive electrical fire from, clouds and vapours passing through it?

2. Is not the *aurora borealis*, the flashing of electrical fire from positive, towards negative clouds at a great

great distance, through the upper part of the atmosphere, where the resistance is least?

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LIV. *Extract of a Letter from Professor Boſe, of Wittemberg, to the Right Honourable George Earl of Macclesfield, Pr. R. S. with Observations thereupon, by Mr. Wm. Watson, F. R. S.*

Wittemberg, August 1, 1753.

Read Dec. 6, 1753. IN the beginning of August 1752, after

great and continued rains, many of our rivers overflowed their banks, and covered the neighbouring grounds, more or less according to their level, to a considerable distance: and the quantity of water was so great, that in some places it was not discharged for more than a week. More particularly the river Unstrut in the territory of the landgrave of Thuringue required a very great time to empty itself, not only as that river runs over a large tract of country, but also as between Artern and great Jena, where this river joins the Sale, its bed in several places is very much confined.

When the inundation was abated, it was observed from the little city Laucha quite up above Artern, not only upon the fields and meadows, but also upon the bushes and trees, that there was a green and very tough viscous slime, which by the help of a stick could be drawn out to two or three ells in length. The subsequent heat of the sun dried this matter, and it appeared like wool upon the bushes; but the fields,

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